A photograph showing the internal components of the D0 detector, specifically the silicon and trigger upgrade. The image shows a circular arrangement of electronic modules and sensors, with a central black cylindrical structure.

Installation of the D0 RunIIB Silicon & Trigger Upgrades

R. P. Smith for
The D0 Collaboration



Just What's Involved Here?

- L0 Installation
 - ◆ Longest Duration of all Upgrade Processes: defines Overall Tevatron Off-time
 - Estimated 14 weeks including contingency
 - ◆ Requires Break in Tevatron Vacuum at D0
 - ◆ Requires Full Opening of Detector, Significant Collision Hall access
- L1 Central Track Trigger ("CTT")
 - ◆ Requires few weeks Collision Hall Access with intermittent short returns thereafter until re-cabling debugged and verified
- L1 Cal Trig Installation
 - ◆ Requires no Collision Hall Access
 - ◆ Complete Disruption of Experiment's Trigger since entire Cal Trigger electronics removed and replaced
- L1 Cal Track Match, L2Beta, L2STT
 - ◆ No Collision Hall access, non-disruptive
- Interleave above with Detector maintenance and repair
 - ◆ Power supplies, individual channel recovery, safety systems



Actually Have a "Running Start"

- Upgrade Installation Tasks Already Achieved:
 - ◆ L0 Silicon - L0 clearance survey; extensive practice with installation tooling; adapter card and 4-Hybrid SVX4 string operating in Gap since 2004 shutdown; N&S mini fuse panels, new Wiener PS and Interlock chassis, Temperature monitoring IO installed
 - ◆ L1CTT - Parallel "slice" running since 2004 shutdown: crate, controller, few DFEB's, installed and operating in detector; Doublet equations on real data exactly the same; Singlet equations under study
 - ◆ L1 Cal - Operating with Slice of Real Calorimeter BLS Data on Sidewalk
 - ◆ L1 CalTrack - L1 triggers (L1 Muon mod + L1CTT + L1Cal) thru trigger and manager crates to L3; data available for unpacker tests; L1CTT transition and MTCxx cables terminated
 - ◆ L2 Beta - Instance of new processor running in L2 for some time
 - ◆ Muon Pipeline depth (L1 Latency) -- Instance of PDT mod now operating in detector
 - ◆ Online upgrades completed



Overall Strategy

- Minimizes overall Luminosity Cost by installing Upgrades in parallel, as rapidly and safely as possible, to ensure integrity of overall Tevatron program at Fermilab
- Depends on cooperative alignment of scheduled work by BD crews for safe, error-free work with TeV beampipe components at D0
- Depends on modest help from AMG (4 one-day, 1 two-day job*) at scheduled times during shutdown
- Depends on critical skills of trained detector specialists during LO work

* Unless done before-hand



Overall Strategy, cont'd

- Meanwhile, during the next few months
 - ◆ Incorporate L1Cal Trig into regular Global Runs in Control Room after ~mid-November
 - ◆ Plan to substantially complete “adiabatic” installation of B&C Layer PDT & SFE mods for latency change
 - ◆ Incorporate four SVX4 hybrid strings into readout to fully exercise L0 readout chain
 - ◆ Push maturation of Straw-Man Trigger List and associated tools to well-understood “V15” Trigger List for running at and beyond 150E30 when hardware installation finished
 - ◆ Continue L1Cal and L1CTT “slice-test” maturation
 - ◆ Rehearse L0 Installation once again in Lab 3
 - ◆ Continue with L2Beta software maturation
 - ◆ Incorporate Cal Trk Match into physics triggers



Some Planning Nuts & Bolts

- LO Installation Schedule Duration: 14 weeks/69 work days beginning March 1
 - ◆ Careful planning
 - ◆ (LO) installation fixture development
 - ◆ Mock-up of critical LO steps
 - ◆ Develop special tooling to reduce opening/closing of EC's/EF's as Tevatron beampipe is disconnected/reconnected and LO tooling is installed
 - ◆ Incorporate valuable experience from 2004 Shutdown when special LO clearance measurements were made
 - ◆ Create contingency by moving lower-risk tasks to 2nd shift
- Understand Overall Manpower Requirements
 - ◆ From FNAL DO Group, Universities
 - ◆ Specific personnel from Laboratory



LO Installation

- Plan with fully loaded MPP
 - ◆ Assign experienced personnel with special "body awareness", (and where necessary) long arms, for close work in tightly constrained space, who must install 2m long multi-million dollar one-of-a-kind object in opening with ~ 1mm clearance
 - ◆ (Show LO Technical Commissioning only because it must be completed before close-up)
- Five-day work week, Lab holiday schedule
- Manage parallel tasks to optimize use of N and S Gaps, minimize overall duration, without generating additional risk



Silicon Installation Milestone Overview

ID	WBS	TASK NAME	START-DATE	FINISH-DATE	DURATION
2	1.5.1	Beginning of RunIIb Tevatron Shutdown	3/01/06	3/01/06	0 w
28	1.5.2.2.1 0	Detector Open, Ready for Access	3/09/06	3/09/06	0 w
34	1.5.2.3.5	RunIIa Be Pipe Disconnected	3/13/06	3/13/06	0 w
45	1.5.2.4.1 0	H Disks Removed	3/20/06	3/20/06	0 w
53	1.5.2.5.7	RunIIa Be Beampipe Removed	3/29/06	3/29/06	0 w
72	1.5.2.8.5	L0 Tooling and Mounts Ready	4/19/06	4/19/06	0 w
76	1.5.2.9.3	L0 Installed	4/21/06	4/21/06	0 w
85	1.5.2.10. 8	RunIIb Be Pipe Connected, L0 Cabled	5/04/06	5/04/06	0 w
88	1.5.2.11. 2	H Disks Installed	5/10/06	5/10/06	0 w
93	1.5.2.12. 4	Silicon Cold and Ready for Technical Commissioning	5/15/06	5/15/06	0 w
97	1.5.2.13. 3	Complete Technical Commissioning of Silicon	5/19/06	5/19/06	0 w
113	1.5.2.15. 9	Detector Closed for Tevatron Resumption	6/06/06	6/06/06	0 w

Tevatron Downtime
14 weeks (69 working days)

**Milestones Shown are from Single Shift
Schedule**



L1 Cal Installation Tasks

ID	WBS	TASK NAME	START-DATE	FINISH-DATE	DURATION
2	1.5.1	Beginning of Run IIb Tevatron Shutdown	3/01/06	3/01/06	0 w
13	1.5.3.2.1.2	Final Cal Noise Studies	3/10/06	3/13/06	0.2 w
13	1.5.3.2.1.3	Decable BLS cables from Trigger Crates	3/13/06	3/20/06	1 w
13	1.5.3.2.1.4	Depopulate & Remove Run I Trigger Crates	3/20/06	4/03/06	2 w
13 7	1.5.3.2.1.5	Install Rack Infrastructure in Active (ADF) racks, Install Patch Panels in Passive Racks	4/03/06	4/24/06	3 w
13	1.5.3.2.1.6	Reconnect BLS cables	4/10/06	4/24/06	2 w
13 9	1.5.3.2.1.7	Install ADF, TAB/GAB, Readout & Controller Crates	4/24/06	5/01/06	1 w
14	1.5.3.2.1.8	Connect Pleated Foil Cables	5/01/06	5/08/06	1 w
14	1.5.3.2.1.9	Connect ADF – TAB/GAB Cables	5/08/06	5/15/056	1 w
14	1.5.3.2.1.10	Connect L1/L2, TFW, SCL, L1CalTrkMat	5/15/06	5/17/06	0.4 w
14 3	1.5.7.2.1.11	L1 Cal Ready for Technical Commissioning	5/17/06	5/17/06	0 w

L1 Cal Ready for Technical Commissioning
~ 2.5 weeks before beam Resumes

Milestones Shown are from Single Shift Schedule



Contingency Analysis

- Can Categorize tasks according to risk to learn where contingency might be earned
 - ◆ Some tasks "incompressible" - Be hazard analysis, SNEG activation, glue curing, manipulation of detector elements
 - ◆ Some tasks lower risk, eminently suited for 2nd shift work: routine detector reconfiguration, scaffolding setup/removal, setting up beam tube purge lines and fixtures
 - ◆ Some tasks incompatible with 2nd shift work - require great care, precision, supervision: TeV Be pipe extraction, LO Mount attachment, LO Insertion, RunIIb Be pipe installation
- Prudent to Schedule, and Manage to, "2nd Shift" Tasks to Earn Contingency



Second Shift Tasks

- Second Shift work earns 7 working days contingency

WBS	Task	Start	Duration*
1.5.2.2.2	Open Muon Shields, EF's	3/01/06	0.1 w
1.5.2.2.4	Remove FPD Vetoes	3/2/06	0.2 w
1.5.2.2.7	Open EF's, CF's, EC's	3/3/06	0.2 w
1.5.2.3.1	Prep for EC/Be Disconnect; Rad Survey	3/6/06	0.1 w
1.5.2.3.3	Cut EC Pipe ends; Record Temps	3/7/06	0.1 w
1.5.2.4.2	Stop SMT Coolant, drain, purge	3/8/06	0.1 w
1.5.2.5.3	Close ECN,EFN, Make Platform at EFN	3/20/06	0.2 w
1.5.2.5.5	Remove Be Pipe from CH	3/21/06	0.1 w
1.5.2.7.1	Remove N Scaffold, Open EFN, ECN, etc.	3/29/06	0.2 w
1.5.2.10.6	Weld EC Beampipe Stubs	4/26/06	0.2 w
1.5.2.14.1	Remove Gap Hardware, Close EC's, EF's,	5/15/06	0.2 w
1.5.2.15.3	Close CF's, EF's	5/22/06	0.2 w
1.5.2.15.5	Extend Muon Shields, Close Clamshells	5/23/06	0.2 w
1,5,2,15,7	Test Magnet Power Supplies	5/24/06	0.6 w

* Some Tasks were already in parallel with others



More Contingency Analysis

- Saturdays represent contingent work days - potentially 13 days , but many task require specialized skills, are physically challenging, so more reasonable harvest: ~ half of Saturdays
- Technical commissioning of Silicon allowed 4 days; generous by one or two, given physicists can also work at night
- Power supply testing at end allowed 3 shifts; two available for unforeseen tasks
- Summary of Contingency:
 - ◆ Night Shifts - 7 days
 - ◆ Saturdays - 6+ days
 - ◆ Silicon Commissioning and Power Supply Testing - 3 days
 - ◆ Total: 16+ days
- 23+% Contingency not seen as excessive for project of this complexity



How Might We Spend Contingency?

- Be Analysis requires unexpected handling measures
- Beampipe leak checking after reconnection
 - ◆ A leaking joint could require detector reconfiguration
- Calorimeter beampipe temperatures lower than anticipated
- Other unanticipated complications

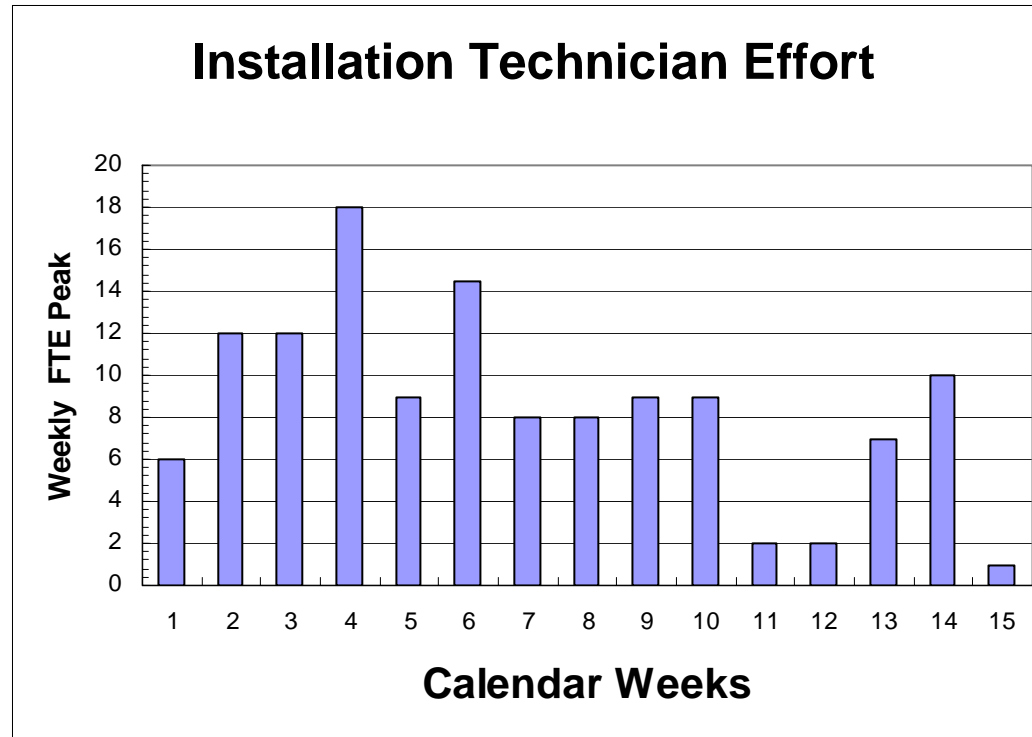


Identified Additional Manpower Needs

- Assuming university teams and lab resources currently available to DO remain available, the identified supplemental manpower requirements are as follows:
 - ◆ LO Installation Expert Engineers: Youri Orlov, Joe Howell, Dan Olis, (Mike Hrycyk)
 - ◆ LO Installation Expert Instrumentalist: Mike Roman
 - ◆ LO Installation Expert Technicians: Dave Butler, Ken Schultz, Bert Gonzalez, Ron Davis
 - ◆ PDT Expert: Sten Hansen, (Boris Baldin)
 - ◆ Four Electrical Techs for PDT mods (2 weeks)
 - ◆ Four Mechanical Techs (duration of shutdown)
 - ◆ Welder (1 day)
 - ◆ CTT Mixer Engineer: Stefano Rapisarda
 - ◆ AMG teams (2 3-man crews, 3 2-man crews)
 - ◆ AD beampipe specialists (4 days)
 - ◆ Fermilab engineer for L1Cal integration/technical commissioning
 - ◆ Short term visitor support for L1Cal Track Match
- The Lab is aware of this list and remains supportive - we anticipate the needs will continue to be addressed



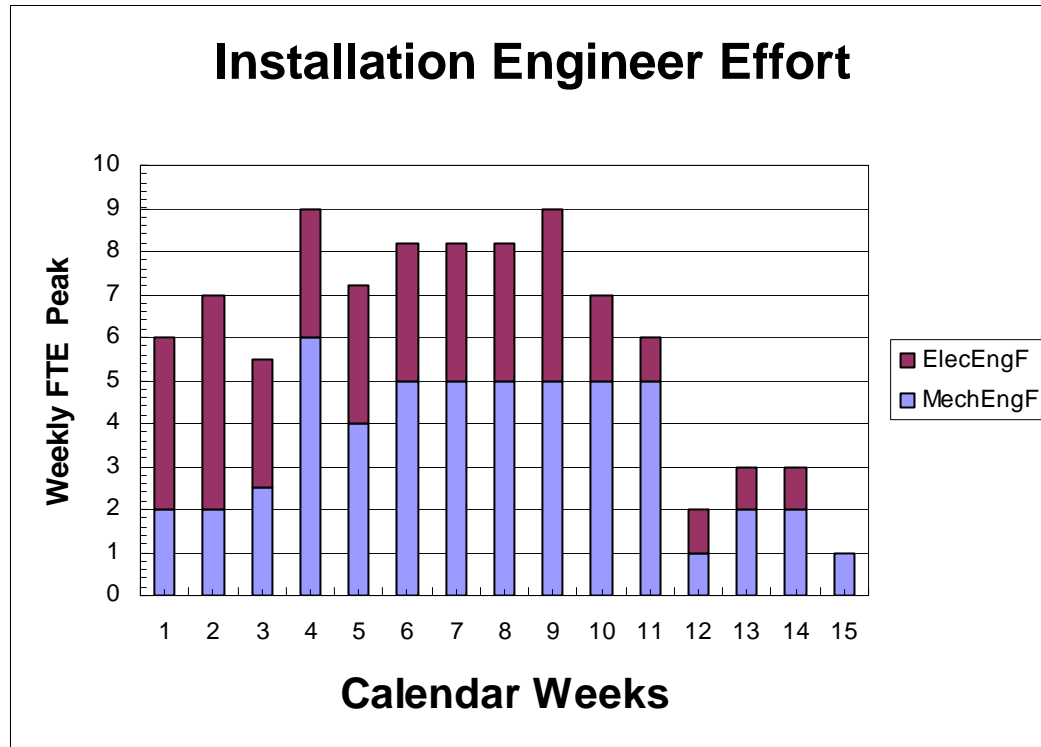
Installation Effort



Workweek = Standard 5 days per week



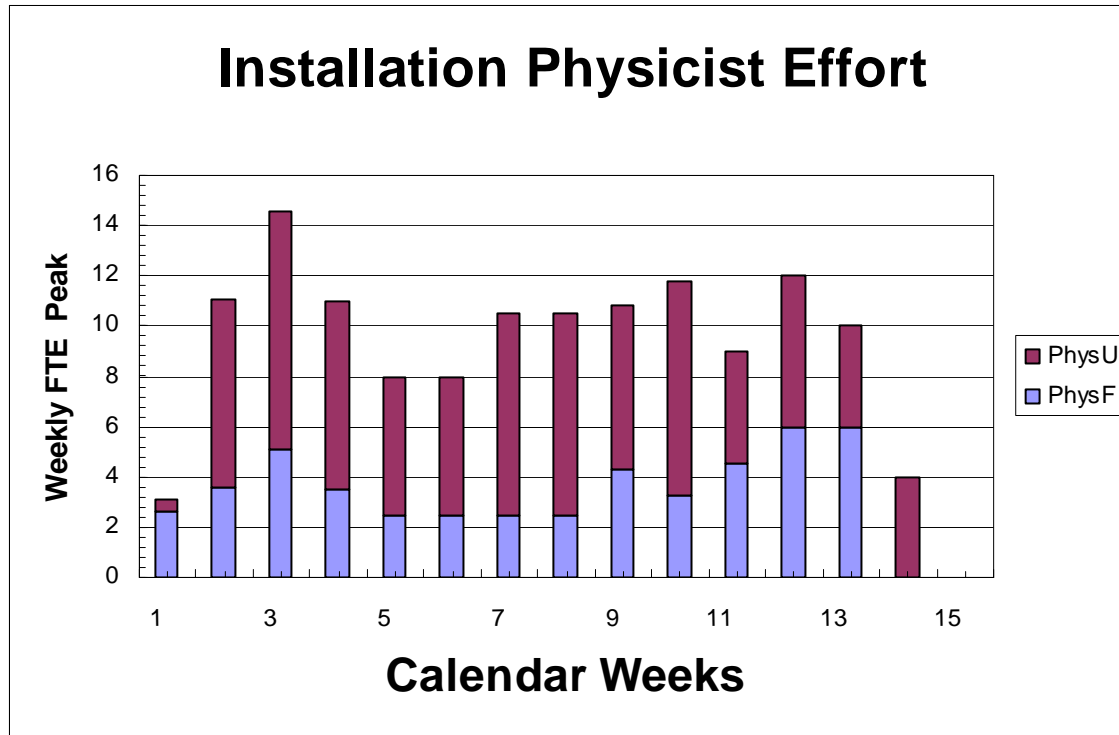
Installation Effort



Workweek = Standard 5 days per week

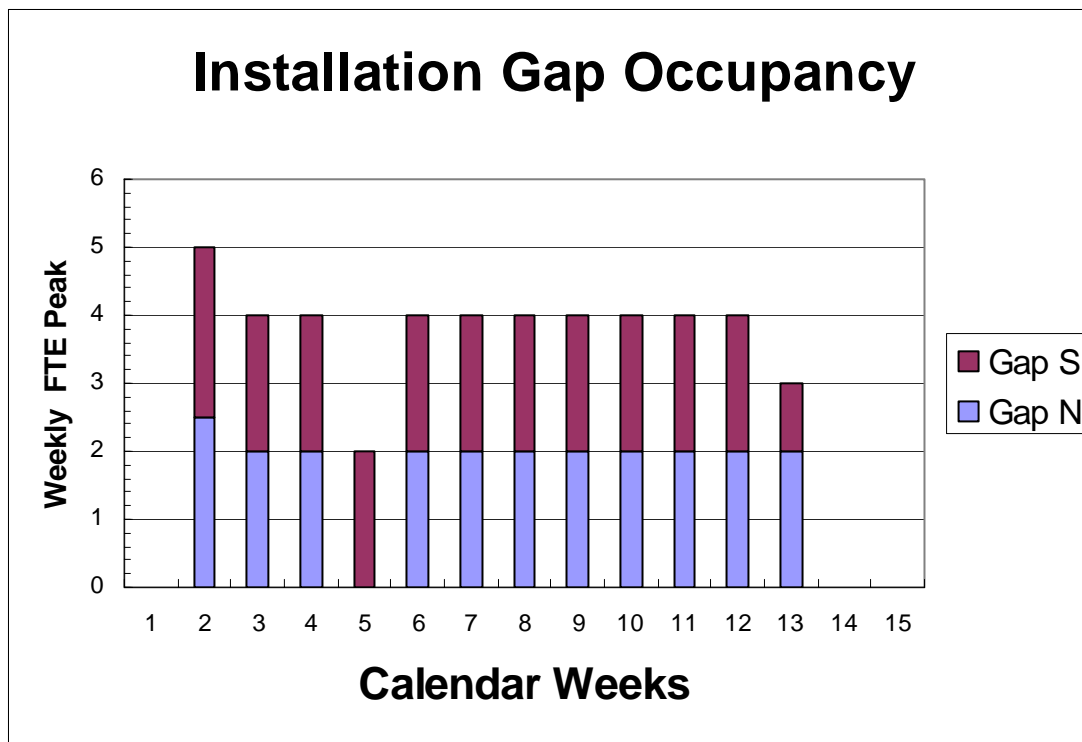


Installation Effort





Detector Gap Occupancy



Per Gap Limit: 2



Conclusions

- Conservative, Informed Evaluation of Duration of Installation Tasks
 - ◆ MPP Used to Evaluate Total Duration, Effort
 - ◆ Contingency earned via select 2nd shift work, some Saturdays
 - ◆ 14 week shutdown schedule includes ~25% schedule contingency
 - ◆ Assuming that the manpower resources outlined within this presentation are available, we expect to be able to implement this plan successfully
- Success depends on significant dedicated effort from collaboration and personnel supporting DO, in addition to itemized additional non-DO personnel, close cooperation of AD, timely assistance of AMG